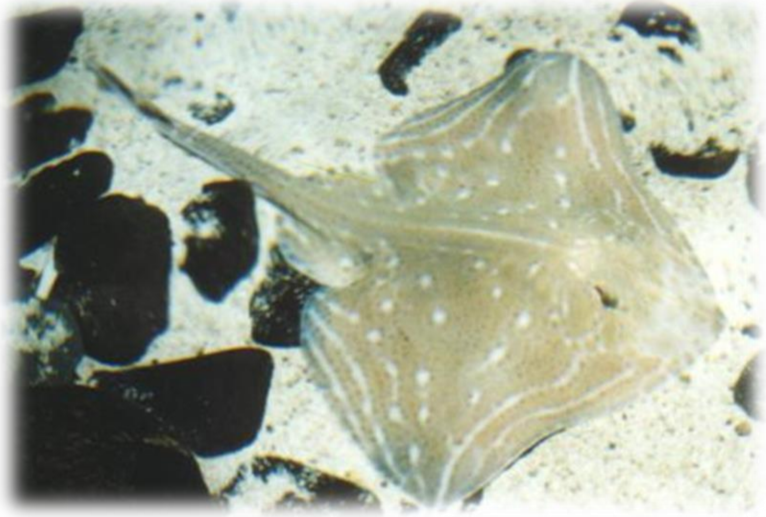
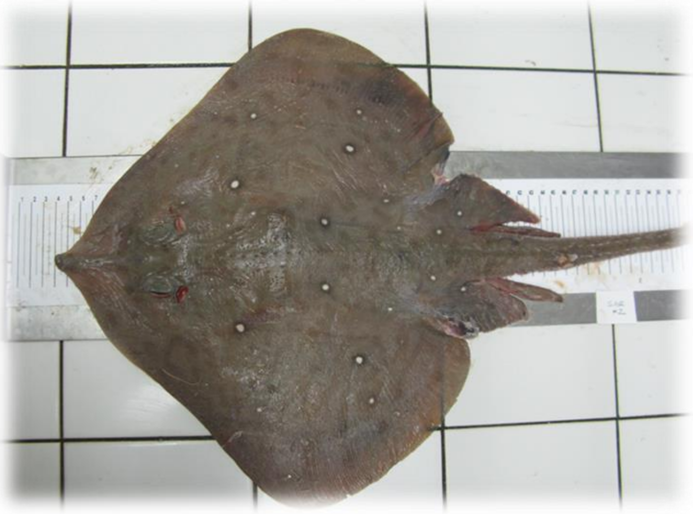
A summary of recent Cefas skate and ray research, with case studies of data-limited species from coastal and offshore waters





Jim Ellis and Sophy McCully Phillips

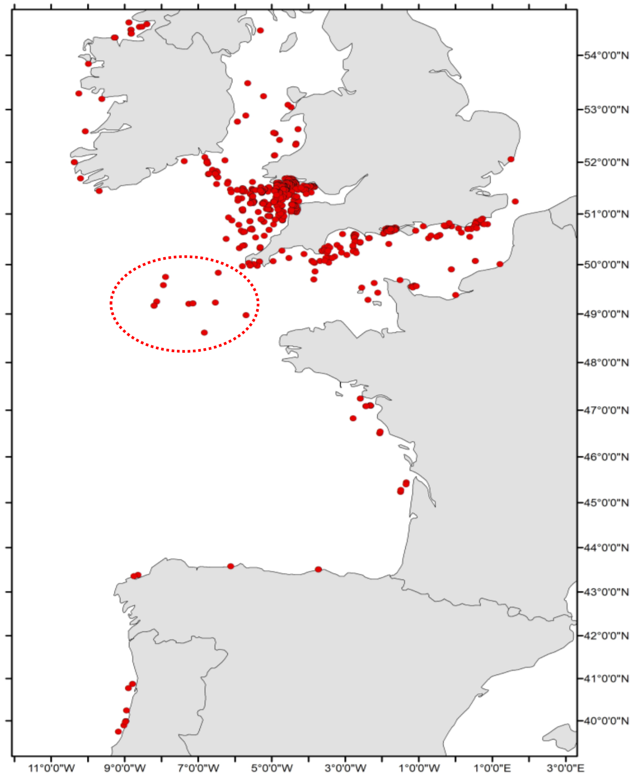
Centre for Environment Fisheries & Aquaculture Science

Cefas

Together we are working for
a sustainable blue future

Spatial distribution

- Data on spatial distribution important for consideration of stock units
- Extensive trawl survey data from around the British Isles
- Wider trawl survey data can have some suspicious records (coding errors and misidentifications)



Ellis, J. R., Cruz-Martinez, A., Rackham, B. D. and Rogers, S. I. (2005). The distribution of chondrichthyan fishes around the British Isles and implications for conservation. *Journal of Northwest Atlantic Fishery Science*, 35: 195–213.

Heessen, H. J. L., Daan, N. and Ellis, J. R. (Eds.) (2015). Fish atlas of the Celtic Sea, North Sea, and Baltic Sea. Wageningen Academic Publishers / KNNV Publishing, 572 pp.

Longer-term temporal changes

- Decline of ‘common skate complex’ during the 1960s, with anecdotal information on the loss of white skate
- Purported disappearance of long-nosed skate from Irish Sea questioned
- Provides important perspective on ‘recent’ changes (e.g. indices using trawl surveys from the 1990s onwards)

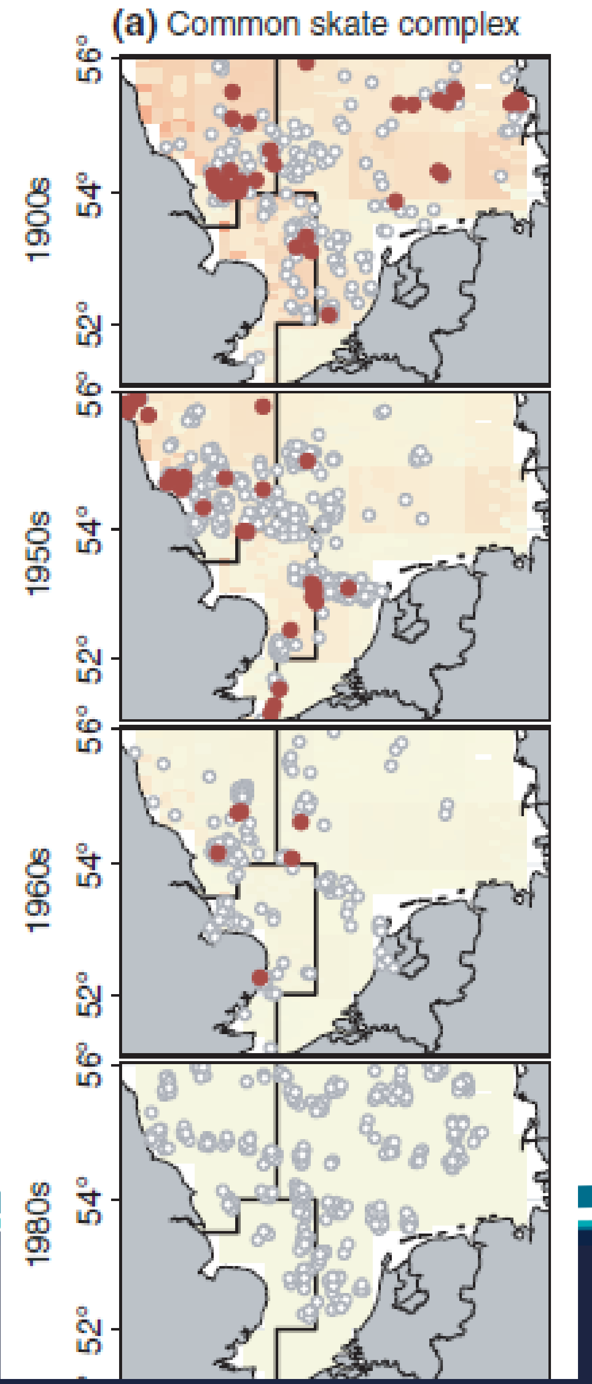
Nature Vol. 290 5 March 1981

Disappearance of common skate *Raia batis* from Irish Sea

K. Brander

Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research, Fisheries Laboratory, Lowestoft, Suffolk NR33 0HT, UK

Records show that the common skate, *Raia batis*, has declined in abundance in the Irish Sea since the early years of the twentieth century, and is now very rare. As I report here, it is possible to calculate the highest mortality which the species will withstand without collapsing. It is likely that the mortality due to fishing has exceeded this level for some time and that the species will not recover while fishing continues. This represents the first clear case of a fish brought to the brink of extinction by commercial fishing.



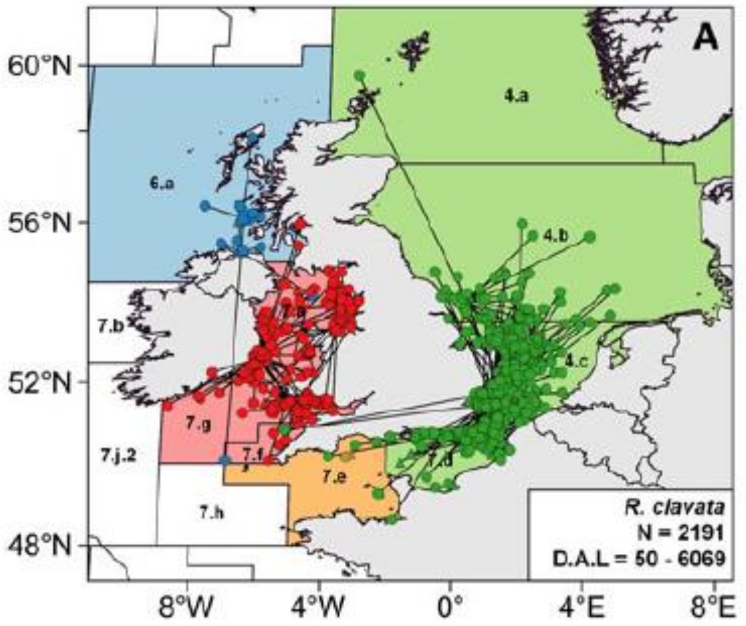
Brander K. (1981) Disappearance of common skate, *Raia batis* from Irish Sea. *Nature* 290, 48–49.

Rogers, S. I. and Ellis, J. R. (2000). Changes in the demersal fish assemblages of British coastal waters during the 20th century. *ICES Journal of Marine Science*, 57: 866–881.

Sguotti, C., Lynam, C. P., García-Carreras, B., Ellis, J. R. and Engelhard, G. H. (2016). The distribution of skates and sharks in the North Sea: 112 years of change. *Global Change Biology*, 22: 2729–2743.

Movements and tagging studies

- Needed to inform on stock units, growth, longevity
- Tagging studies initiated in late 1950s/1960s, with some further tagging in the mid 1990s
- More tagging work since 2003 onwards (opportunistic on trawl surveys, and some dedicated field studies)



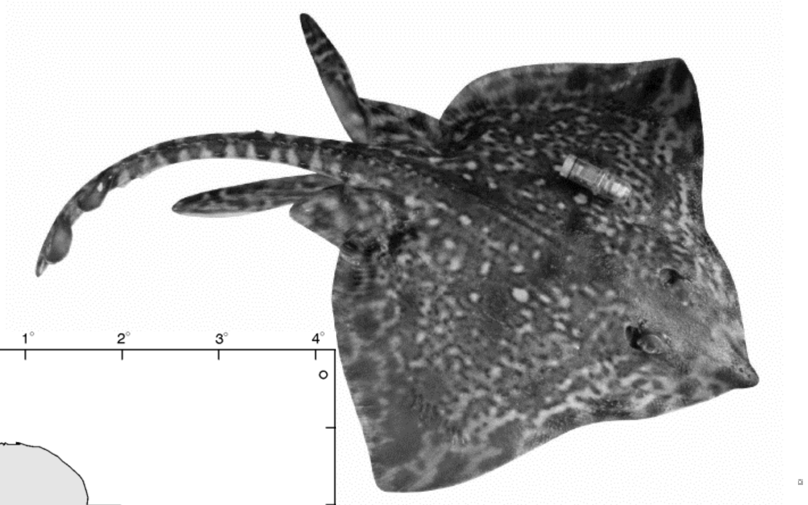
Walker, P., Howlett, G. and Millner, R. (1997). Distribution, movement and stock structure of three ray species in the North Sea and eastern English Channel. *ICES Journal of Marine Science*, 54: 797–808.

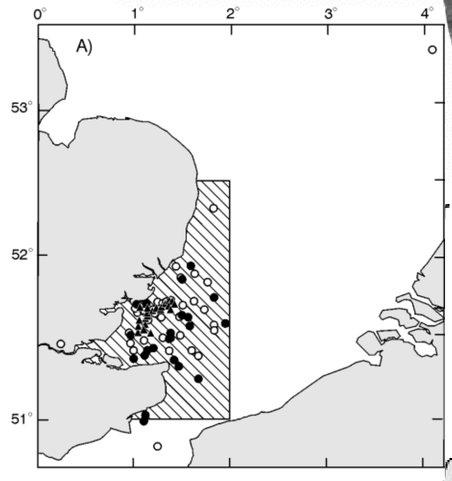
Ellis, J. R., Morel, G., Burt, G. and Bossy, S. (2011). Preliminary observations on the life history and movements of skates (Rajidae) around the Island of Jersey, western English Channel. *Journal of the Marine Biological Association of the United Kingdom*, 91: 1185–1192.

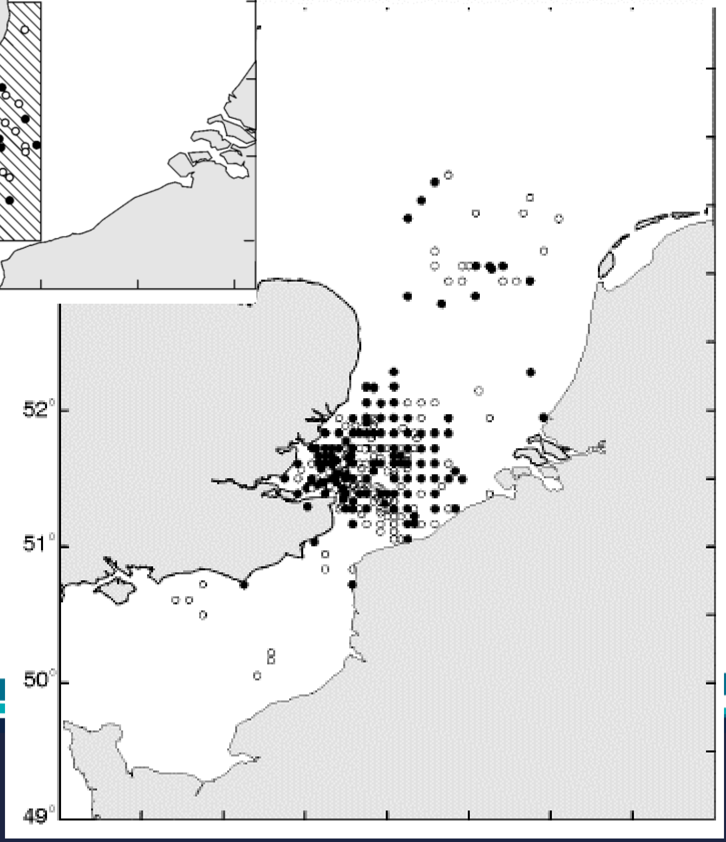
Bird, C., Burt, G. J., Hampton, N., McCully Phillips, S. R. and Ellis, J. R. (2020). Fifty years of tagging skates (Rajidae): Using mark-recapture data to evaluate stock units. *Journal of the Marine Biological Association of the United Kingdom*, 100: 121–131.

Electronic tagging

- Important approach to understanding movements and behaviour
- Cefas scientists deploying DST's on thornback ray in 1990s/early 2000s (tag development and studying outer Thames stock)
- More recent studies to provide information on post-release mortality







Hunter, E., Buckley, A.A., Stewart, C. & Metcalfe, J.D. (2005a). Migratory behaviour of the thornback ray, *Raja clavata* L., in the southern North Sea. Journal of the Marine Biological Association of the U.K., 85: 1095-1105.

Hunter, E., Buckley, A.A., Stewart, C. & Metcalfe, J.D. (2005b). Repeated seasonal migration by a thornback ray in the southern North Sea. *Journal of the Marine Biological Association of the U.K.,* 85: 1199-1200.

Discards and discard survival

- Initial work on ‘survival’ conducted in the mid 2000s
- Information on at-vessel mortality from a range of inshore fleets and information on survival (tank trials and electronic tagging
- Data used to inform on Landing Obligation

Enever, R., Catchpole, T. L., Ellis, J. R. and Grant, A. (2009). The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. *Fisheries Research*, 97: 72–76.

Enever, R., Revill, A.S., Caslake, R. and Grant, A. (2010). Discard mitigation increases skate survival in the Bristol Channel. *Fisheries Research*, 102: 9–15.

Ellis, J. R., Burt, G. J., Grilli, G., McCully Phillips, S. R., Catchpole, T. L. and Maxwell, D. L. (2018). At-vessel mortality of skates (Rajidae) taken in coastal fisheries and evidence of longer-term survival. *Journal of Fish Biology*, 92: 1702–1719.

Ribeiro Santos, A., Wright, S., Silva, J.F. and Catchpole, T. (2021). Estimating survivability of discarded rays in English fisheries. Evidence on discard survival from Cefas tagging studies. Cefas Technical Project Report. https://randd.defra.gov.uk/

Reproductive biology

- Extensive macroscopic data on maturity-at-length for several species
- Limited data on egg-laying rates/fecundity
- Ongoing work on 'nursery grounds'
- Quantitative measurements for validating maturity planned, and updated analyses of maturity data

Holden, M.J., Rout, D.W. and Humphreys, C.N. (1971) The rate of egg laying by three species of ray. *Journal du Conseil*, 33: 335–339.

Holden, M.J. (1975) The fecundity of *Raja clavata* in British waters. *Journal du Conseil*, 36: 110–118.

Ellis, J. R. and Shackley, S. E. (1995). Observations on egg-laying in the thornback ray. *Journal of Fish Biology*, 46: 903–904.

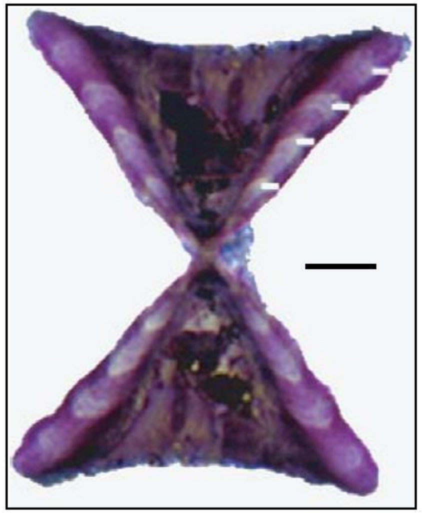
McCully, S. R., Scott, F. and Ellis, J. R. (2012). Length at maturity and conversion factors for skates (Rajidae) around the British Isles, with a critique of earlier studies. *ICES Journal of Marine Science*, 69: 1812–1822.

Gordon, C. A., Hood, A. R. and Ellis, J. R. (2016). Descriptions and revised key to the eggcases of the skates (Rajiformes: Rajidae) and catsharks (Carcharhiniformes: Scyliorhinidae) of the British Isles. *Zootaxa*, 4150: 255–280.

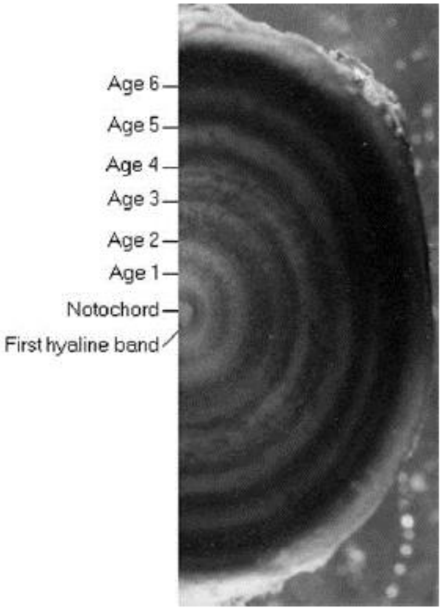
Age and growth

- Holden and co-workers undertook growth studies (vertebrae and tagging data)

➢ Ongoing work reviewing existing parameters, other data sources (tagging, length frequency) and planned collection of contemporary vertebral samples



Gallagher, M.J., Nolan, C.P. and Jeal, F. 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. *Journal of Northwest Atlantic Fishery Science*, 35: 47–66.



Whittamore, J.M. and McCarthy, I.D. 2005. The population biology of the thornback ray, *Raja clavata* in Caernarfon Bay, north Wales. *Journal of the Marine Biological Association of the United Kingdom*, 85: 1089–1094.

Taylor, A.J. and Holden, M.J. (1964) The preparation and use of vertebrae for age determination in rays. ICES CM, 145, 1–3 pp.

Holden, M.J. (1972) The growth rates of *Raja brachyura, R. clavata* and *R. montagui* as determined from tagging data. *Journal du Conseil*, 34: 161–168.

Holden, M.J. and Vince, M.R. (1973) Age validation studies on the centra of *Raja clavata* using tetracycline. *Journal du Conseil*, 35: 13–17.

Brander, K. and Palmer, D. (1985). Growth rate of *Raja clavata* in the Northeast Irish Sea. *Journal du Conseil*, 42: 125–128.

Feeding ecology

- Most skates are crustacean feeders when young, with larger individuals either consuming larger crustaceans (e.g. thornback ray) or becoming more piscivorous (e.g. blonde ray)
- Large shagreen ray feed on other elasmobranchs

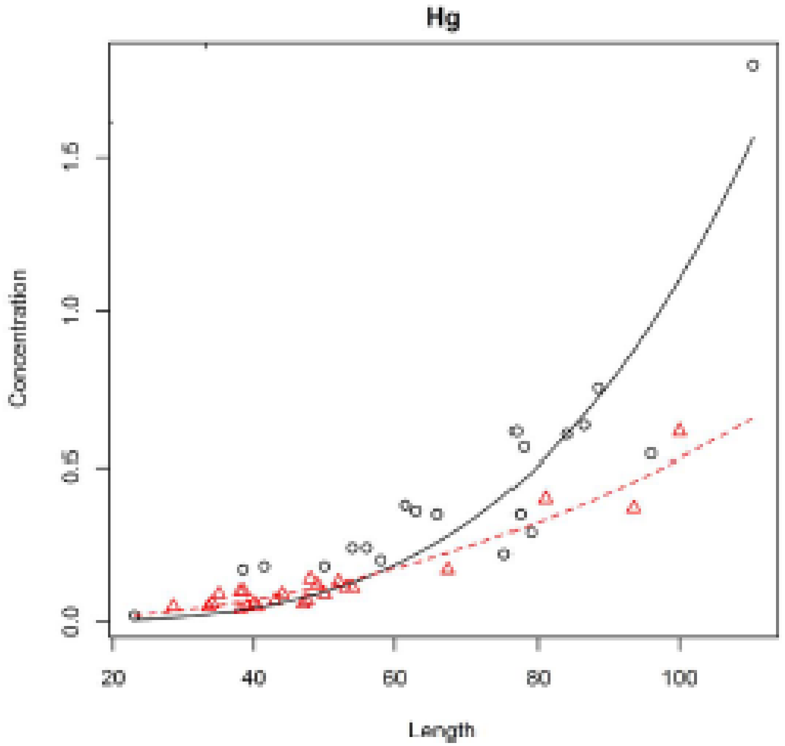
➢ Improved 'feeding modes' for future ecosystem / trophic / multispecies models

Holden, M.J. and Tucker, R.N. (1974) The food of *Raja clavata, R. montagui, R. naevus* and *R. brachyura* in British waters. *Journal du Conseil*, 35: 189–193.

Ellis, J. R., Pawson, M. G. and Shackley, S. E. (1996). The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the North-East Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 76: 89–106.

Contaminants

- Elasmobranchs often long-lived and high trophic level - potential for bioaccumulation and biomagnification of contaminants
- Skates and rays associated with the seafloor – potential for greater exposure?
- Recent studies indicate some large skates may have mercury concentrations greater than seafood health guidelines



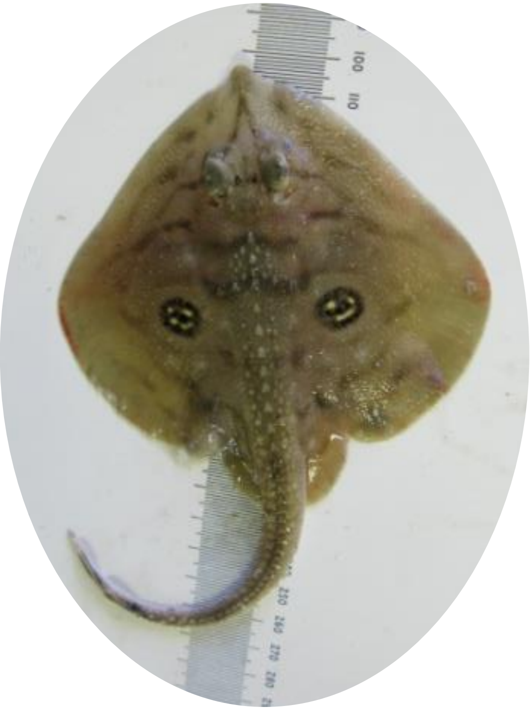
Nicolaus, E. E. M., Barry, J., Bolam, T. P. C., Lorance, P., Marandel, F., McCully Phillips, S. R., Neville, S. and Ellis, J. R. (2017). Concentrations of mercury and other trace elements in two offshore skates: sandy ray *Leucoraja circularis* and shagreen ray *L. fullonica*. *Marine Pollution Bulletin*, 123: 387–394.

Which species do we have more data for?

RJC

RJM

RJH



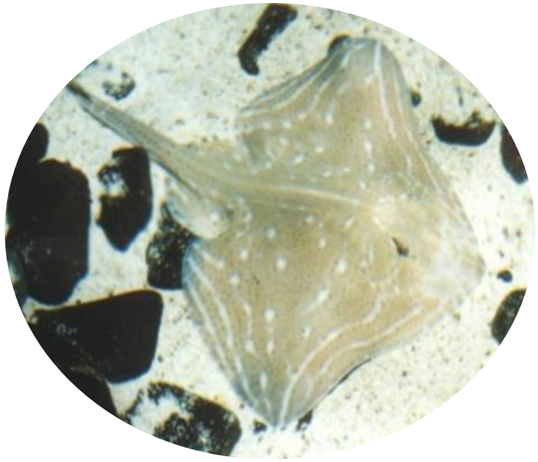
RJN

Ellis, J. R., Burt, G. J., Cox, L. P. N., Kulka, D. W, and Payne, A. I. L. (2008). The status and management of thornback ray *Raja clavata* in the south-western North Sea. ICES CM 2008/K:13, 45 pp.

Ellis, J. R., Silva, J. F., McCully, S. R., Evans, M. and Catchpole, T. (2010). UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. ICES CM 2010/E:10, 38 pp.

Silva, J. F., Ellis, J. R. and Catchpole, T. L. (2012). Species composition of skates (Rajidae) in commercial fisheries around the British Isles, and their discarding patterns. *Journal of Fish Biology*, 80: 1678–1703.

Which species are (usually) more data-limited?



Inshore species RJU and RJE

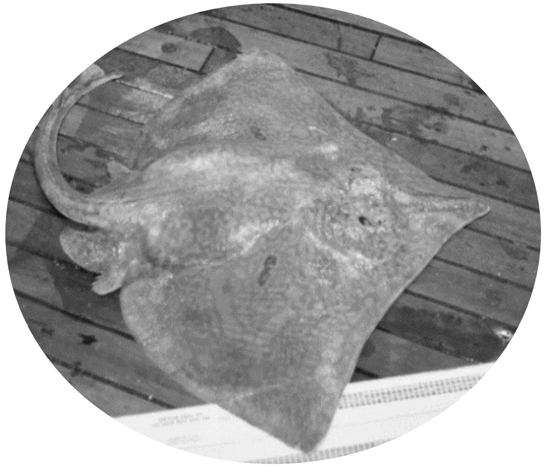
Larger skates

Offshore species RJI and RJF

Ellis, J. R., McCully, S. R. and Brown, M. J. (2012). An overview of the biology and status of undulate ray *Raja undulata. Journal of Fish Biology*, 80: 1057–1074.

McCully Phillips, S. R., Scott, F. and Ellis, J. R. (2015). Having confidence in Productivity Susceptibility Analyses: A method for underpinning scientific advice on skate stocks? *Fisheries Research*, 171: 87–100.

Which species are (usually) more data-limited?



Inshore species RJU and RJE

Larger skates

Offshore species RJI and RJF

Small-eyed ray *Raja microocellata* (RJE)

Jonathan Couch
(1789–1870)

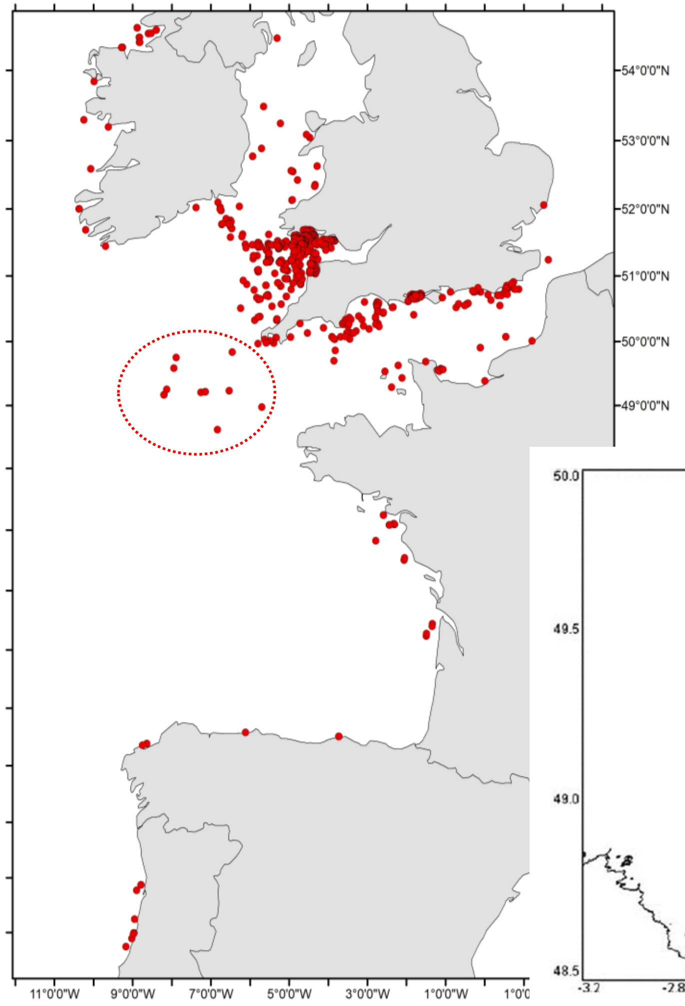
Col. George Montagu
(1753–1815)

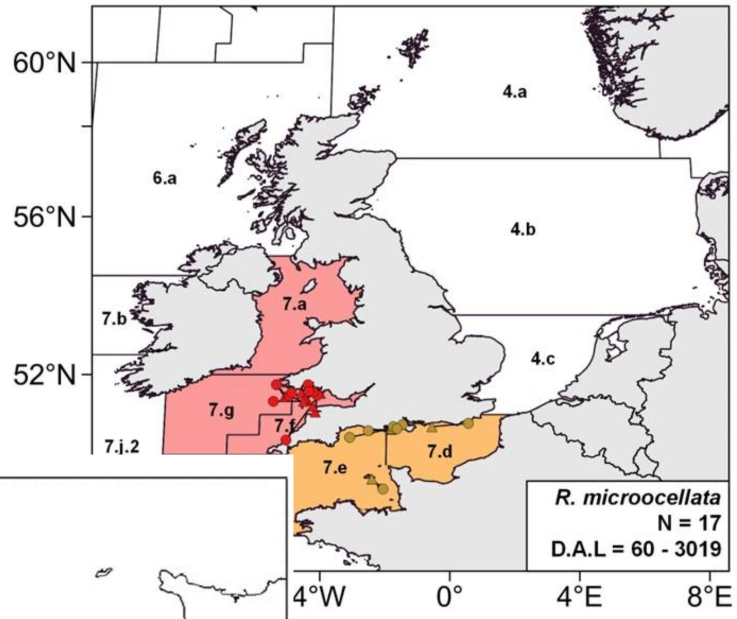
Occurrence in trawl surveys

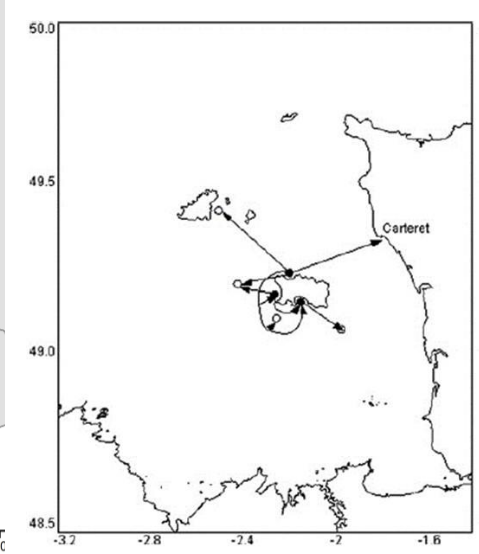
Survey	Number	Length range	Depth range
Irish Sea / Bristol Chanel BTS	**1734**	**12–89 cm**	**10–108 m**
Q4SWIBTS	527	13–89 cm	28–90 m
DCRDC	117	13–86 cm	19–148 m
Q1SWOTTER	110	18–86 cm	40–103 m
South-west BTS	**103**	**13–83 cm**	**30–93 m**
Eastern Channel BTS			
WCGFS			
FV Carhelmar			
Young Fish Survey			
Other			

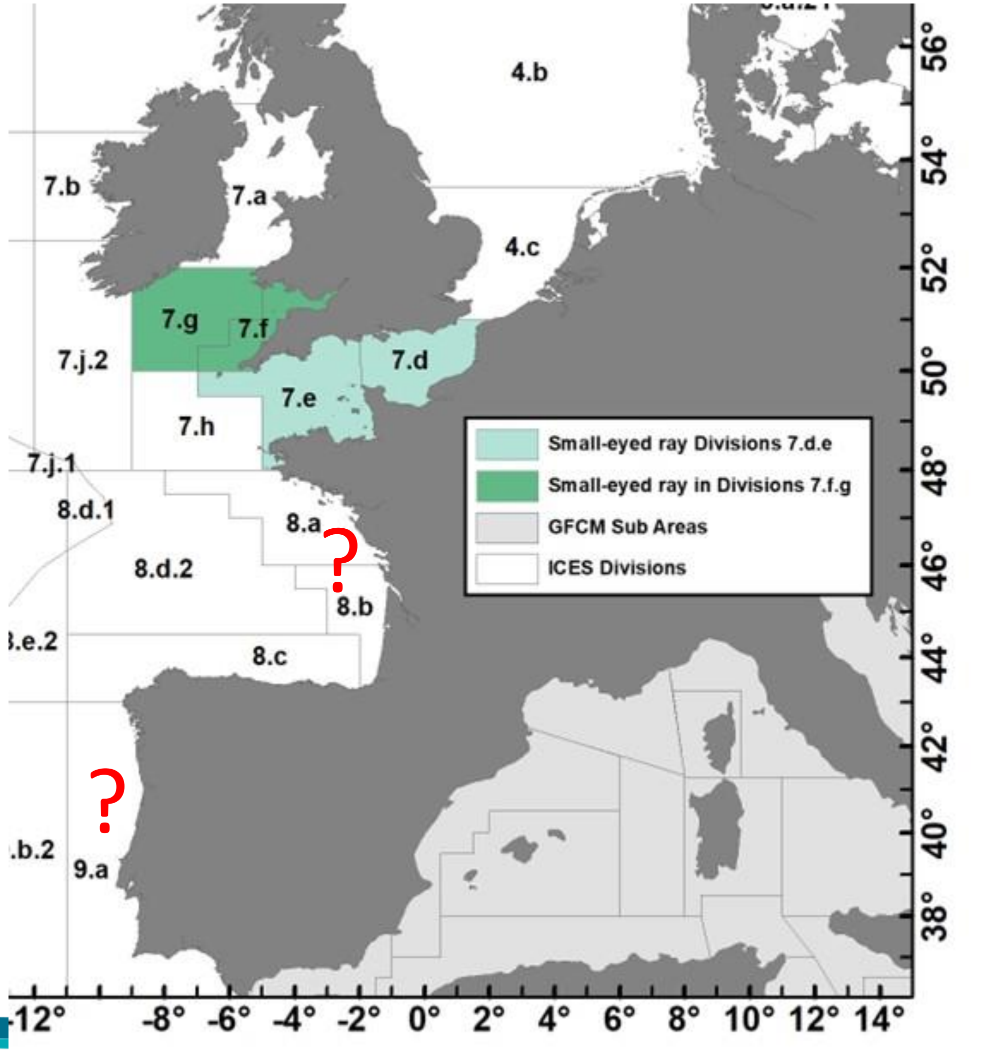
Survey	Years	Number	Length range	Depth range
IE-IGFS	2003–2021	330	27–86 cm	35–117 m
EVHOE	1997–2021	289	27–89 cm	20–86 m
FR-CGFS	1988–2021	145	27–88 cm	12–69 m
PT-IBTS	2002–2021	31	36–73 cm	20–72 m
SP-NORTH	1990–2021	17	36–82 cm	40–83 m
BTS-VIII	2011–2021	9	30–72 cm	20–60 m
NIGFS	2008–2021	0		
SP-ARSA	2000–2020	0		

Distribution, movements and stock units

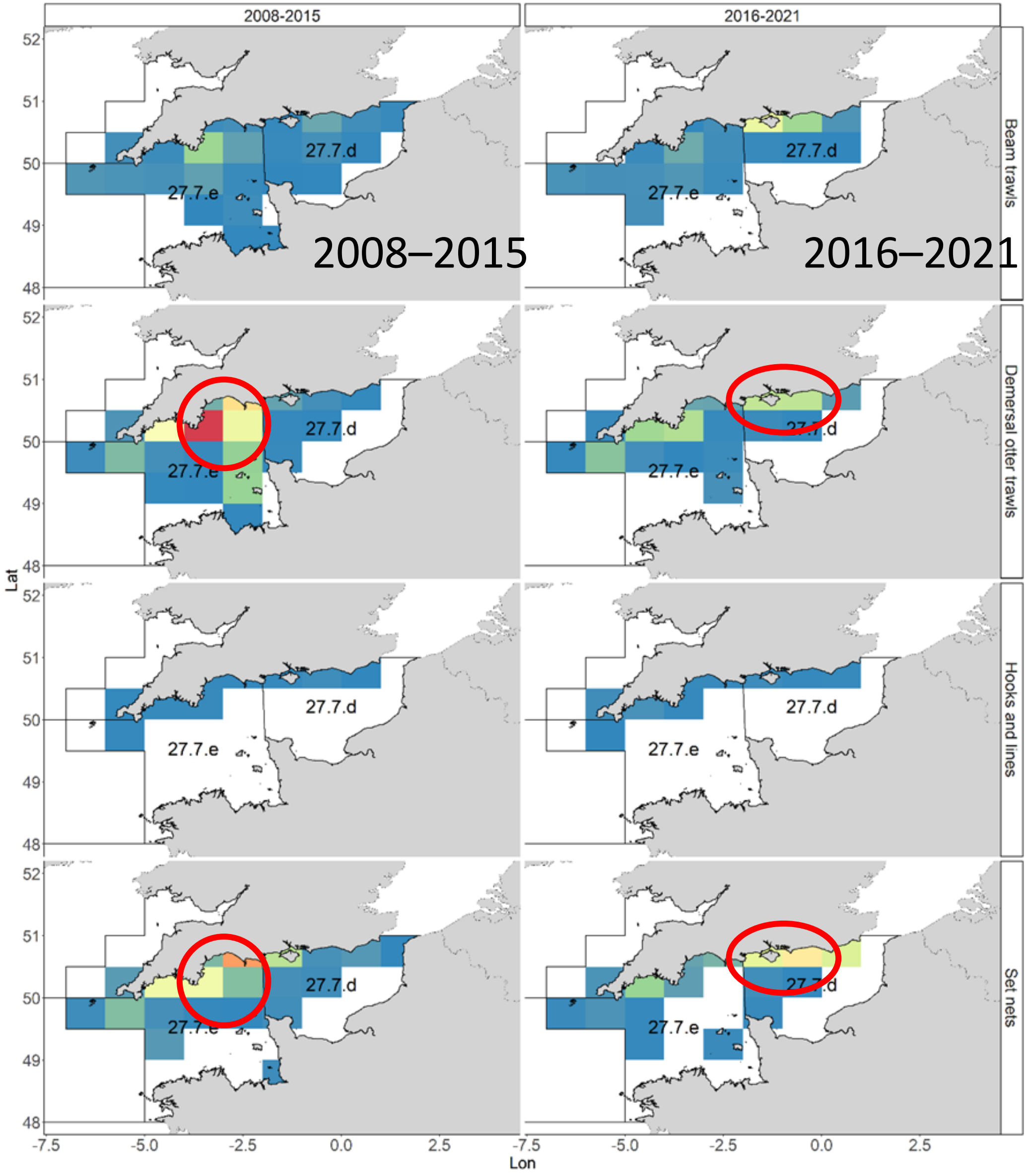








UK Landings data



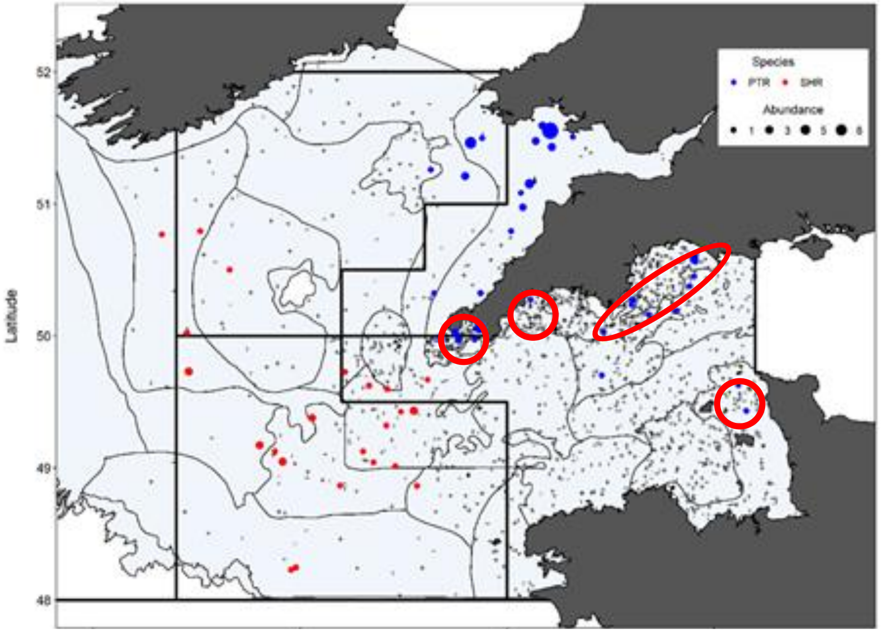
Beam trawl

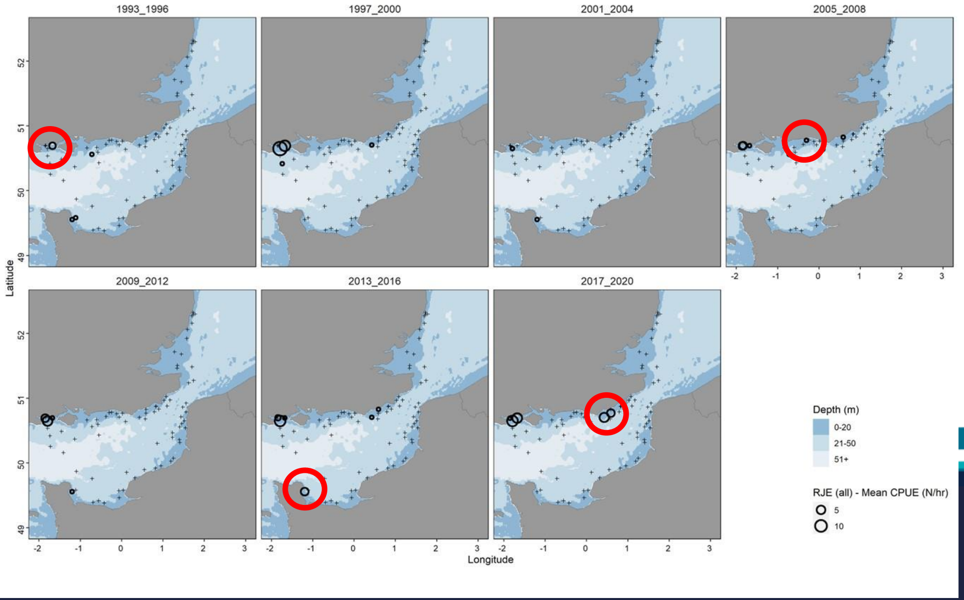
Otter trawl

Hooks & lines

Gillnets

Surveys

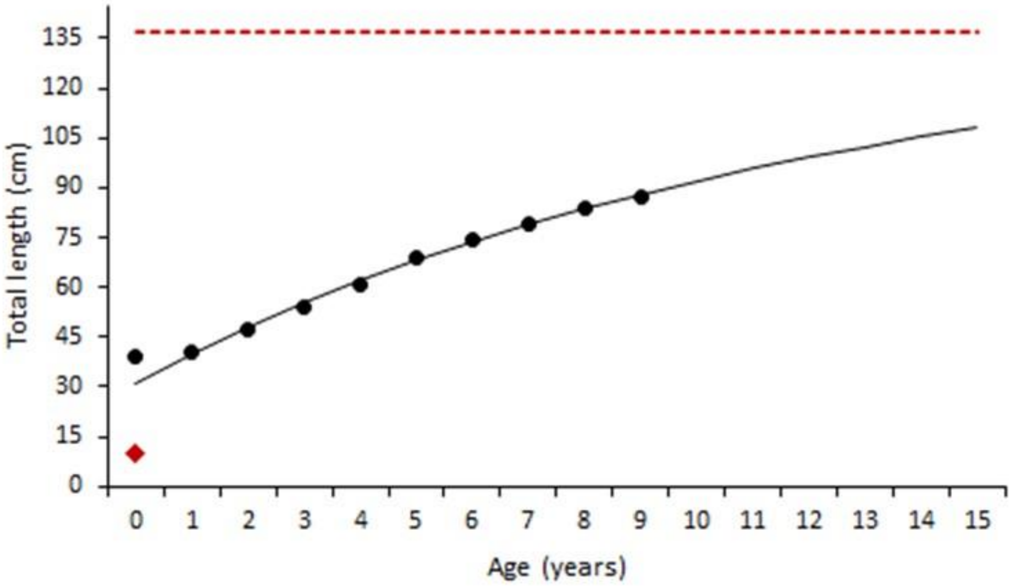


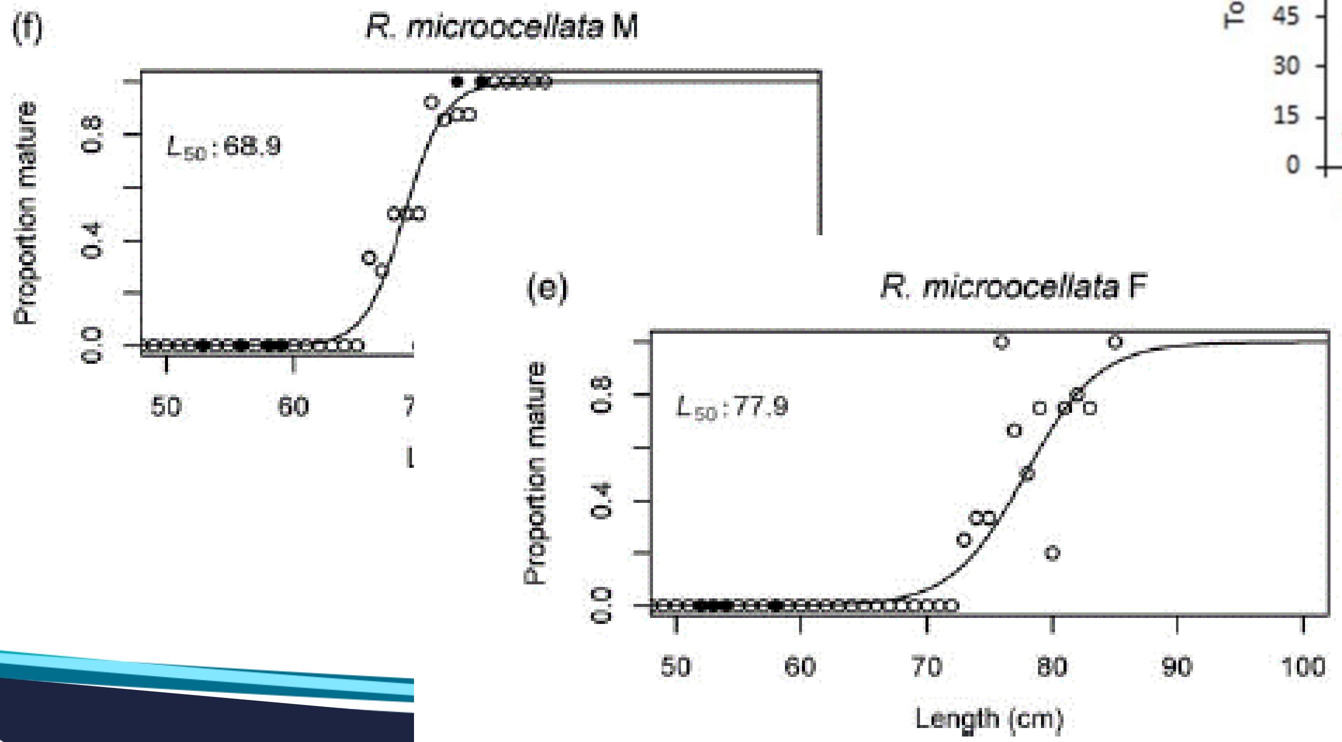


Science

Biological data

- One published age and growth study*, but estimated VBGP not plausible





- More robust maturity data needed

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Cefas

*Ryland, J.S. and Ajayi, T.O., 1984. Growth and population dynamics of three *Raja* species (Batoidei) in Carmarthen Bay, British Isles. *Journal du Conseil internationale pour l'Exploration de la Mer*, 41: 111–120.

RJE summary

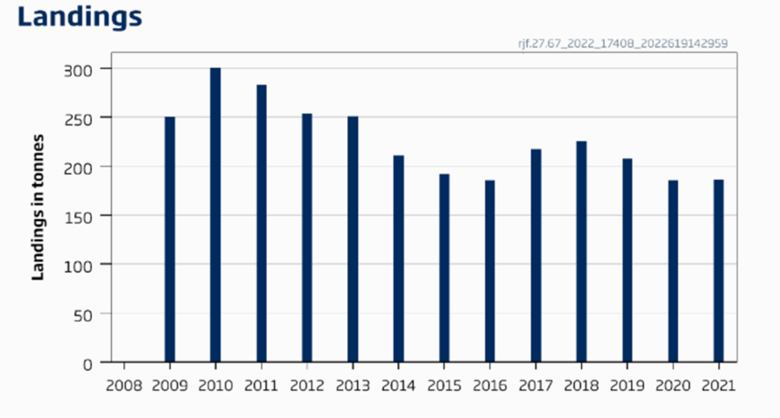
- Discontinuous distribution but can be predominant skate locally
- Historical accounts indicate this to be the longer-term (natural) state
- Trawl surveys have limited spatial overlap with the species' habitat - dedicated survey effort would be needed for more robust monitoring
- The status in the English Channel is uncertain, but data even more limited for the Atlantic coasts of France, Spain and Portugal
- More robust biological studies are required

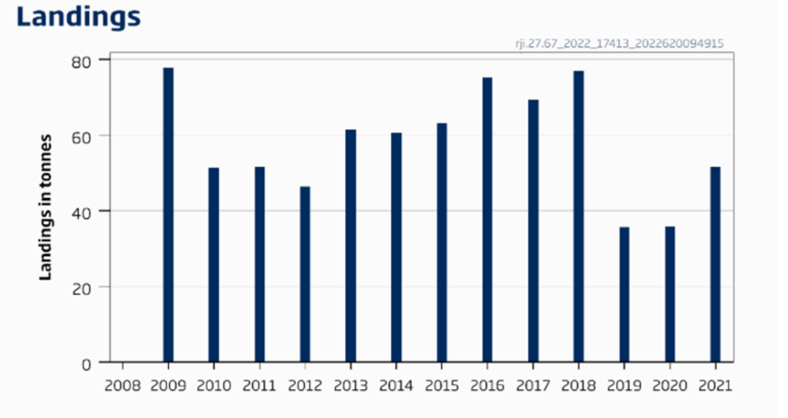
Sandy ray *Leucoraja circularis* (RJI) and Shagreen ray *Leucoraja fullonica* (RJF)

McCully, S. & Walls, R. 2015. *Leucoraja fullonica*. The IUCN Red List of Threatened Species 2015.

McCully, S., Ellis, J., Walls, R. & Fordham, S. 2015. *Leucoraja circularis*. The IUCN Red List of Threatened Species 2015

- × life history very data limited*
- × no survey indices used = Cat. 5 assessment (based on landings)





Rationale for study

- Large bodied
- Commercially important and harvested as part of generic ‘skate and ray’ TAC
- Prioritisation exercise and PSA highlighted these species for priority study

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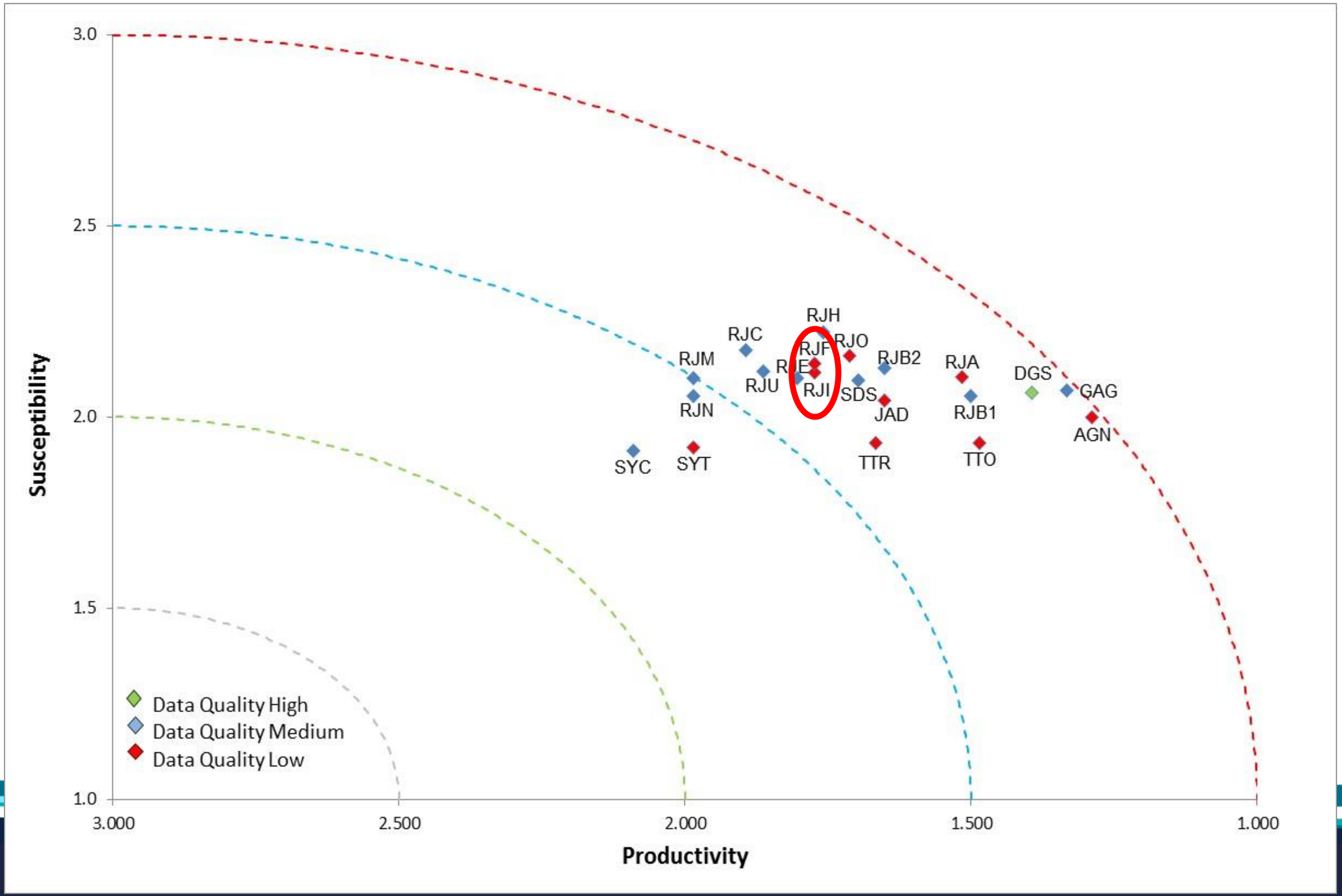
journal homepage: www.elsevier.com/locate/fishres

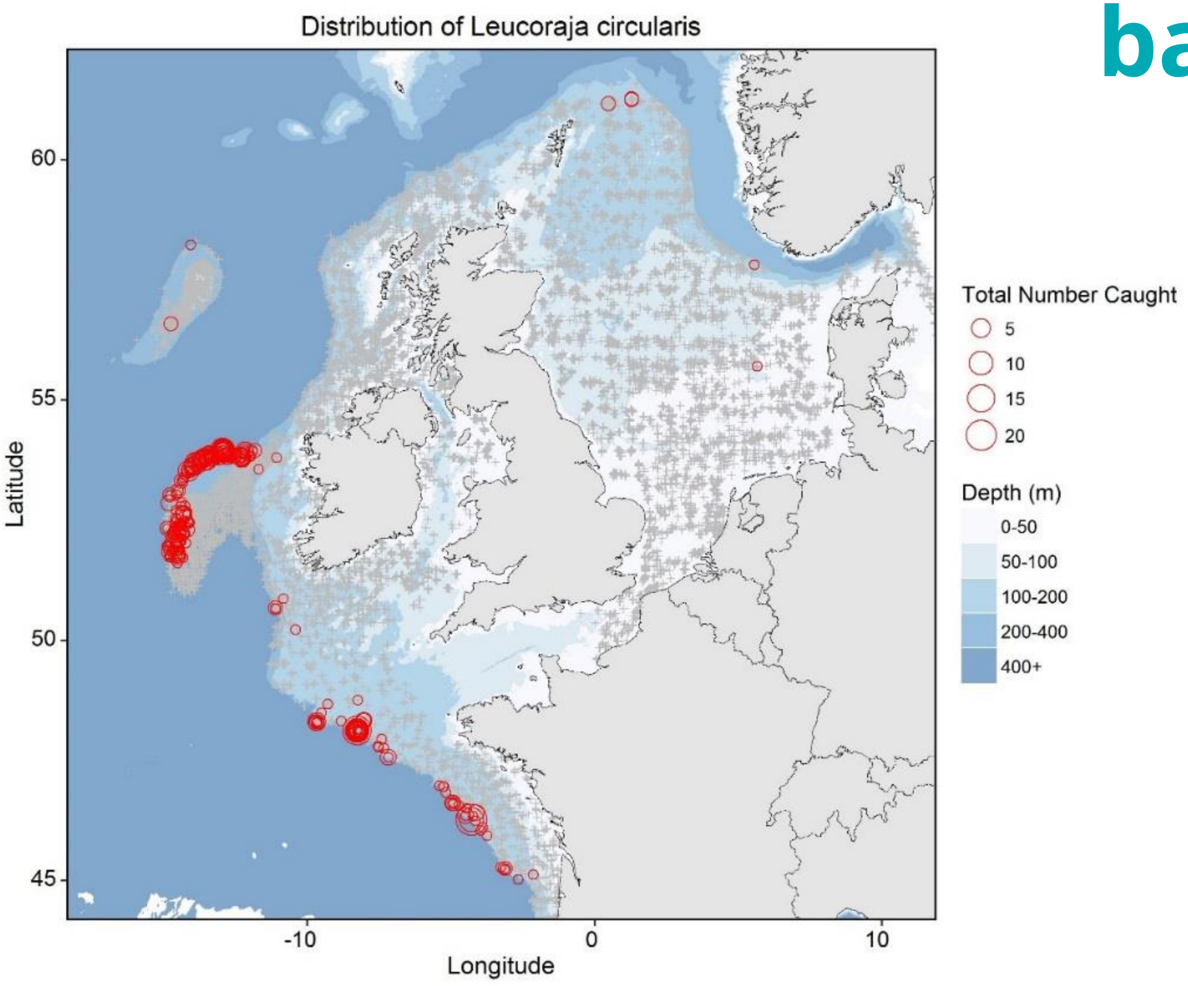
Having confidence in productivity susceptibility analyses: A method for underpinning scientific advice on skate stocks?

Sophy R. McCully Phillips[a,*], Finlay Scott[b], Jim R. Ellis[a]

[a] Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, UK
[b] European Commission—Joint Research Centre, Via Enrico Fermi 2749, I-21027 Ispra, VA, Italy

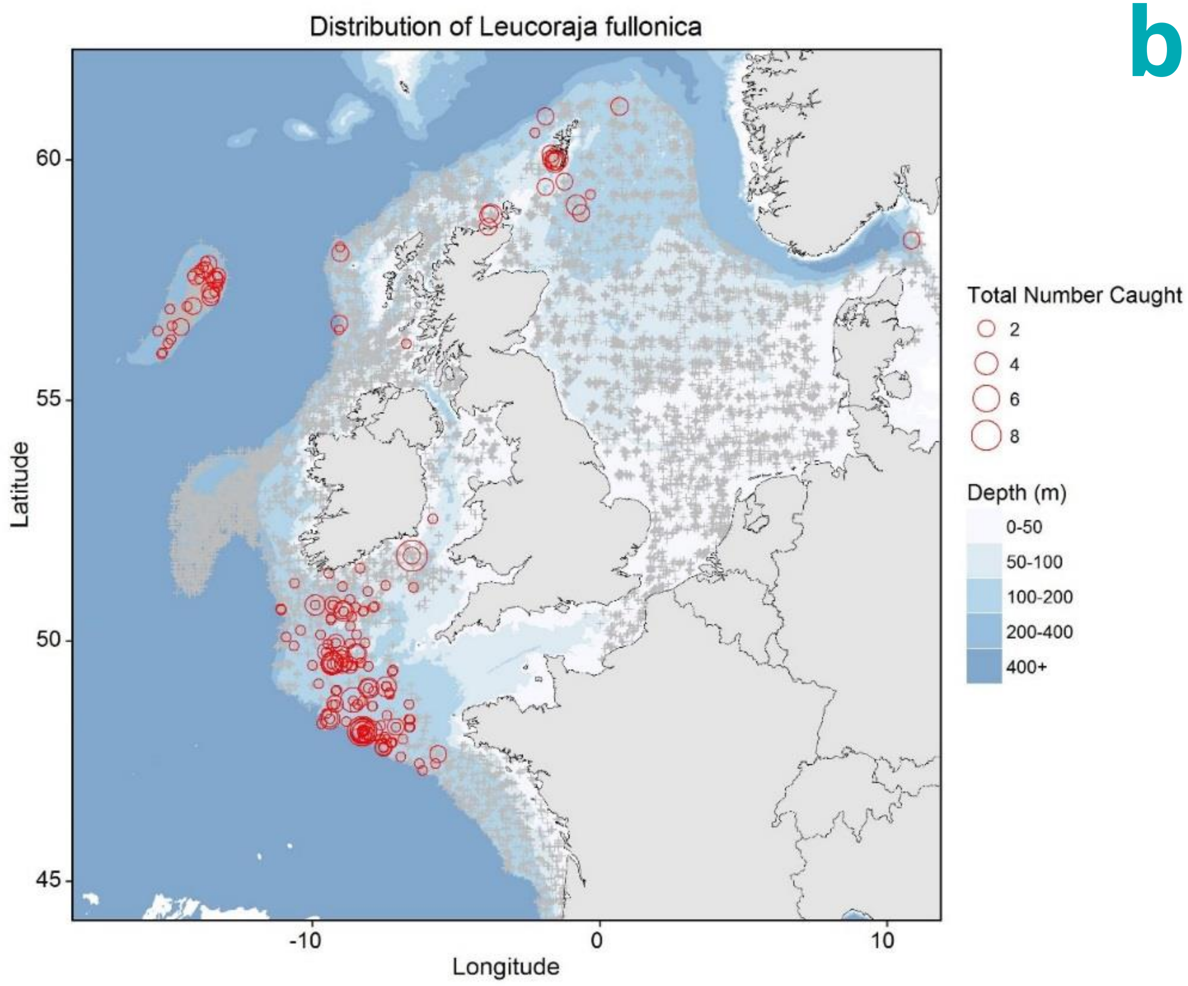


Sandy ray spatial and bathymetric distribution



- Occurs along the outermost part of the continental shelf and slope in the Celtic Sea, including the Porcupine Bank
- Occasional records were made from the Rockall Bank and northern North Sea.
- Most common at 300 – 450 m depth

Shagreen ray spatial and bathymetric distribution



- Shagreen ray occurs on outer continental shelf and upper slope, including Rockall Bank
- Most common at 100 – 200 m depth

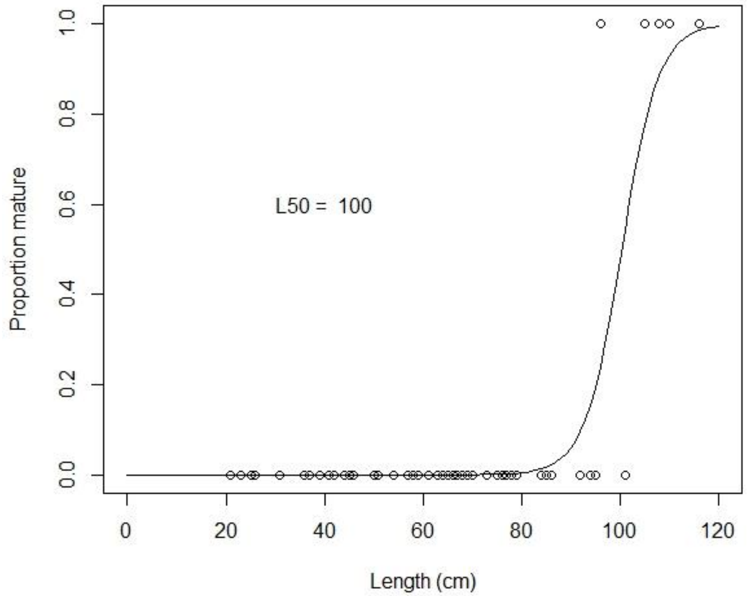
Sample collection

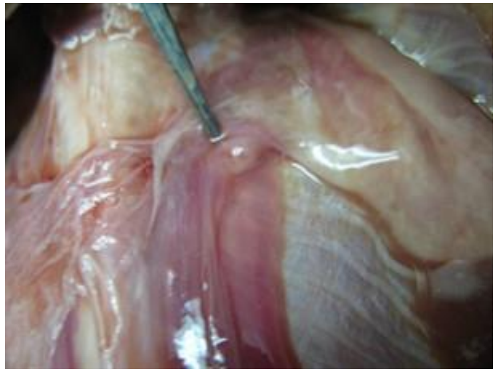
Shagreen ray n = 54
Females: n = 29 (28 – 100 cm)
Males: n = 25 (19 – 86 cm)

Sandy ray n = 116
Females: n = 69 (21 – 116 cm)
Males: n = 47 (23 – 93 cm)

Fish retained during EVHOE, Porcupine Bank and Cefas surveys (2014-2019)

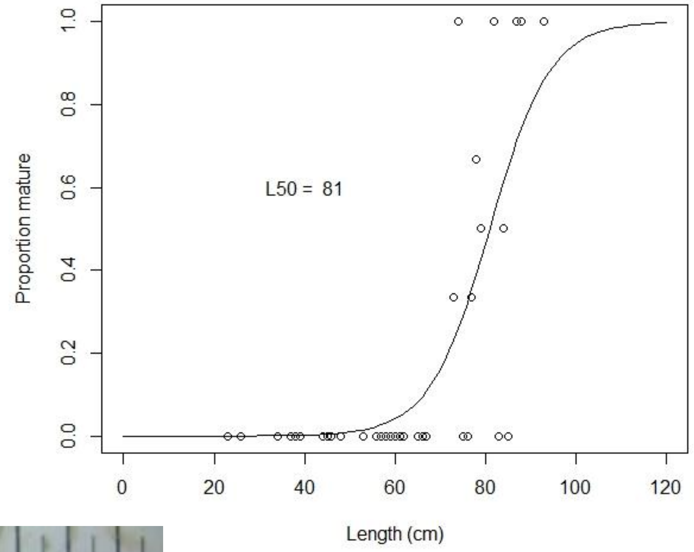
Female reproductive parameters

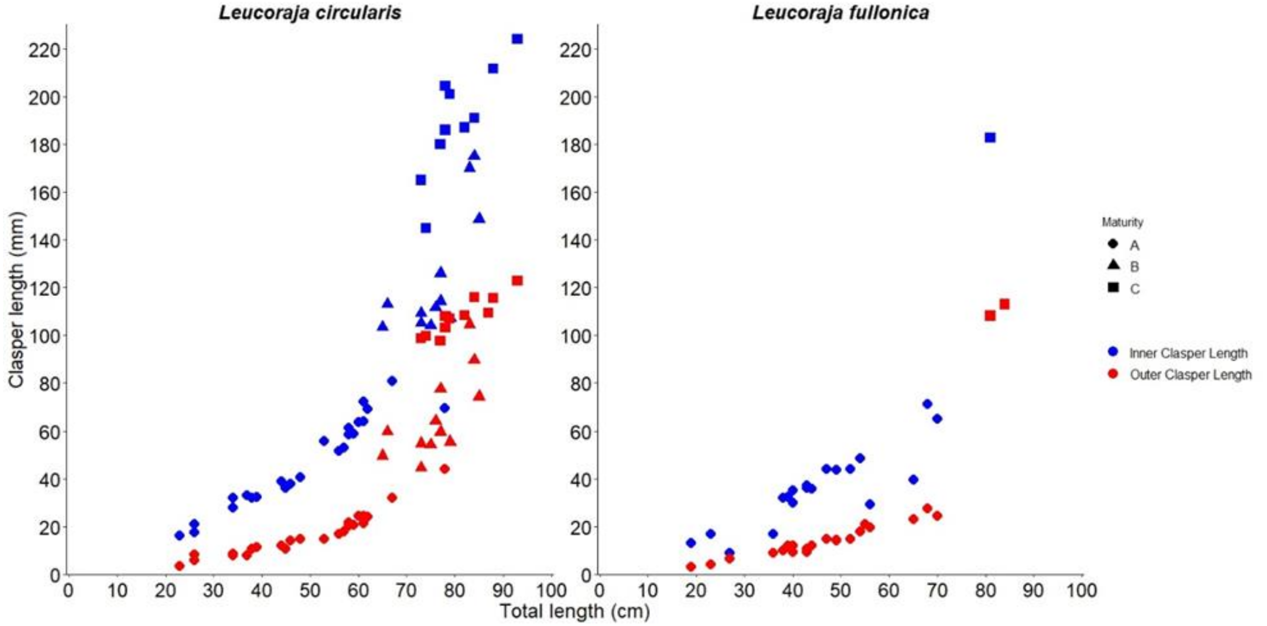




- L_{50} = 100cm L_T for sandy ray, undefined for shagreen ray
- Mature oocytes were 23 – 38 mm
- Shell gland width of mature skate > 40 mm in sandy ray and ~25mm in shagreen ray

Male reproductive parameters

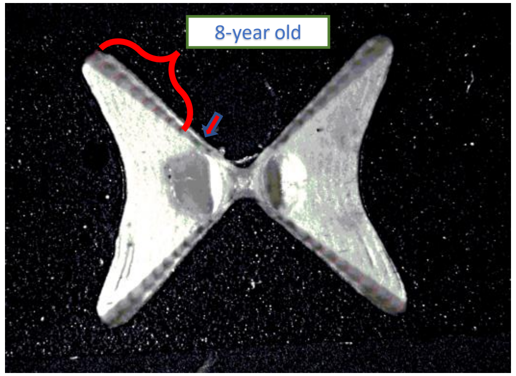


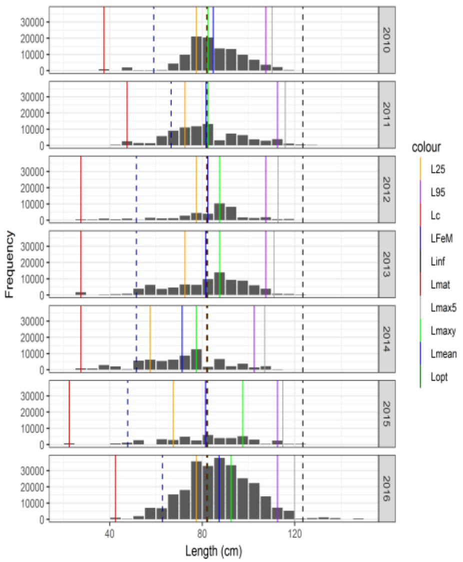


- L_{50} = 81 cm L_T for sandy ray and undetermined for shagreen ray
- Outer clasper length more robust fit to macroscopic maturity

RJI and RJF Summary

- Largest biological study to date
- Large L_{50} vindicates early prioritisation and inherent vulnerability
- More vulnerable than other species managed in group TAC





Future….?

- More mature shagreen ray samples
- Ageing of specimens
- Fine-scale analysis of catch and effort data
- Explore alternative data-limited assessment methods
- Tagging studies